# Chapter 6. Sacramento River Hydrologic Region

## Setting

The Sacramento River Hydrologic Region includes the entire drainage area of the state's largest river and its tributaries, extending from the Oregon border downstream to the Sacramento – San Joaquin Delta. The region covers 27,246 square miles including all or a portion of 20 predominately rural northern California counties, and extends from the crest of the Sierra Nevada in the east to the summit of the Coast Range in the west. The northernmost area, mainly high desert plateau, is characterized by cold, snowy winters with only moderate rainfall, and hot, dry summers. The mountainous parts in the north and east typically have cold, wet winters with large amounts of snow providing runoff for summer water supplies. The Sacramento Valley floor has mild winters with less precipitation and hot dry summers. Overall annual precipitation in the region generally increases as you move from south to north and west to east. The heavy snow and rain that falls in this region contributes to the overall water supply for the entire state.

The many rivers and streams that are tributary to the Sacramento River provide important riparian habitat that is critical for many aquatic and terrestrial species including the spring-run Chinook salmon (Oncorhynchus tshawytscha), winter-run Chinook salmon (Oncorhynchus tshawytscha) and Central Valley steelhead (oncorhynchus mykiss). This region is the only known area for the winter-run Chinook. The valley floor region section adjoining the river, provide some of the most important wintering areas along the Pacific Flyway for many varieties of waterfowl. The region also houses several wetland and waterfowl preserves that provide nesting and migration areas for threatened avian species including the bald eagle and Swainson's hawk and numerous species of neotropical birds. All of these valuable resources are vital components of the ecosystem and contribute to the ecological health of the entire state.

The Sacramento River Hydrologic Region also encompasses all or a portion of six of the state's 18 national forests. Lassen, Mendocino, Modoc, Plumas, Shasta-Trinity and Tahoe Basin national forests are contained or contiguous to the region and contribute to the dynamics of its vast landscape. These federal lands are each managed with specific goals for fish and wildlife such as the recovery of the spotted owl or the Chinook salmon, as well as for hydroelectric power and sustainable timber harvest. Such diverse goals often call for creative management strategies.

Agriculture is the region's largest industry, contributing a wide variety of crops including rice, grain, tomatoes, field crops, fruits and nuts. Crop statistics show that irrigated agricultural acreage in the region peaked during the 1980s and has since declined with a little more than 2 million acres irrigated in 2000. Excess applied irrigation water generally returns to the supply system through drainage canals, or recharges groundwater. Basin efficiency is usually very good because downstream users recycle return flows for their own use. In some places, return flows are the only water source for downstream agricultural users.

The southern portion of the Sacramento River Hydrologic Region is experiencing rapid population growth and urbanization. While California experienced a statewide population increase approaching 15 percent from 1990 to 2000, growth rates in the Sacramento metropolitan region have exceeded this trend. According to California Department of Finance projections, Sacramento County's population increased by 17.5 percent between 1990 and 2000, and is projected to grow by 26 percent between 2000 and 2010 to more than 1.5 million people. Similarly, the adjoining urban areas in Placer, El Dorado and Yolo counties are also experiencing the same levels of extensive growth and urban expansion. This ongoing rapid rate of urbanization is expected to generate significant land and water use challenges for the entire southern portion of the Sacramento River region, including adequate drought-period water supplies, growth in flood plains, loss of productive farmland, and the preservation of sensitive environmental habitats.

For the central and northern portions of the Sacramento River region, most urban development has occurred along the main highway corridors. Although a few of the larger cities in the region, such as Sacramento, divert most of their water from the larger rivers, the principal source of water for most of the urban and rural communities throughout this region is groundwater. The Sacramento Valley is recognized as one of the foremost groundwater basins in the state. In the rural mountain areas of this region, domestic supplies come almost entirely from groundwater.

## Population

The population of the Sacramento River Hydrologic Region was 2,593,000 in 2000, which represents about 8 percent of California's total population. The following table (Table 6-1) provides an additional breakdown by county for populations, land areas, and the resulting population density. Geographically, Siskiyou County has the largest acreage in the region, 6,287 square miles, but with a 2000 population of only 44,750 the population density is about 7 persons per square mile. On the other hand, Sacramento County is the most populated county in the region, with a density of 1,274 persons per square mile. When looking at the map of the region in Figure 6-2, it should be noted that both of these counties are only partially in the region. However, these statistics are useful in portraying the environment of the region, which, except for Sacramento, is predominately rural in nature with low population ratios per square mile.

Although 2000 population numbers indicate lower densities than other developed regions of the state, it is projected that the Sacramento River region's total population will increase to more than 4.5 million by the year 2030. Figure 6-3 provides a graphical depiction of the Sacramento River region's total population from 1960 through 2000, with current projections to 2030. This growth will have a significant impact on shaping the natural resources of the region. Population per square mile decreases as you move farther north into the region, which contains large areas of agriculture and forested lands, both private and public.

Future land use planning and decisions, at both the state and local level, will need to consider the changing complexion of the region, as well how to best use and preserve the vast open spaces and abundant natural resources in the region.

**Table 6-1**
**Sacramento River Region Population Density By County**

| COUNTY | POPULATION ( YEAR 2000 ) | SQUARE MILES | PERSONS PER SQUARE MILE |
|---|---|---|---|
| Butte | 204,500 | 1639 | 125 |
| Colusa | 19,050 | 1151 | 17 |
| El Dorado | 159,700 | 1711 | 93 |
| Glenn | 26,750 | 1315 | 20 |
| *Lake | 58,800 | 1258 | 47 |
| *Lassen | 34,300 | 4557 | 8 |
| *Modoc | 9,375 | 3944 | 2 |
| *Napa | 125,400 | 754 | 166 |
| Nevada | 92,200 | 958 | 96 |
| Placer | 248,900 | 1404 | 177 |
| Plumas | 20,750 | 2554 | 8 |
| Sacramento | 1,230,600 | 966 | 1,274 |
| Shasta | 165,200 | 3785 | 44 |
| *Sierra | 3,610 | 953 | 4 |
| *Siskiyou | 44,750 | 6287 | 7 |
| Sutter | 79,400 | 603 | 132 |
| Tehama | 55,800 | 2951 | 19 |
| *Trinity | 13,000 | 3179 | 4 |
| Yolo | 169,400 | 1013 | 167 |
| Yuba | 60,700 | 631 | 96 |
| * represents counties only partially covered within the region | | | |

California Dept. of Finance (July, 2001 Estimated)

## Water Supply and Usage

Because of the weather patterns that produce a high level of precipitation in the region, major water supplies from the region are provided through the development of reservoirs and from direct groundwater pumping, which historically has recharged through the winter months. Major reservoirs in the region provide water supply, recreation, power, environmental, and flood control benefits. The Central Valley Project (CVP) is the largest water project in the state, and includes Shasta Lake, Whiskeytown Lake, Keswick Reservoir and Folsom Lake in this region. A large portion of the water supplied by CVP is delivered for agriculture purposes, both in this region and as water exports to other regions. The U.S. Bureau of Reclamation's (USBR) Solano Project provides urban and agricultural water supply to parts of the Sacramento River Region and parts of the San Francisco Bay region. The major water supply facilities of the State Water Project (SWP) are along the Feather River basin in this region, consisting of Lake Oroville, Thermalito Afterbay, Lake Davis and Frenchman Reservoir. SWP water serves both urban and agricultural uses in this region and are exported south to other drier regions of the state. A large amount of water from both CVP and SWP reservoirs is released downstream to maintain environmental water quality standards in the Sacramento – San Joaquin Delta. Such storage releases are critical in the summer and fall, to prevent ocean salt water from penetrating east into the Delta during high tidal cycles.

There are several other, smaller reservoirs that add to the overall surface water supply. In total, the region has 43 reservoirs, with a combined capacity of almost 16 million acre-feet. Major reservoirs in the region provide not only water supply, but also are the source of recreation, power generation, and other environmental and flood control benefits. In addition, the region has a network of creeks and rivers that convey water for use throughout the region and also provide nesting and rearing grounds for major fish and wildlife species. Figure 6-4 provides a graphical presentation of the categories of the water supply sources that are used to meet the developed water uses in this hydrologic region for 1998, 2000 and 2001. Water use in the Sacramento River region is mostly for agricultural production with more than 2.1 million irrigated acres in 2000. Agricultural products include a variety of crops such as rice and other grains, tomatoes, field crops, fruits and nuts. A substantial number of acres of rangeland in this region are also used for livestock management. Much of the economy of the region relies on agricultural water supplies, which are diverted and distributed through extensive systems of diversion canals and drains. Basinwide water use efficiency is generally high, because many return flows from fields are captured by drainage systems and then re-supplied to other fields downstream. In some places, these return flows are the primary water source for other downstream uses, including agriculture and wildlife refuges. In addition, excess applied irrigation water can return to the supply system by percolating as groundwater recharge.

The larger urban areas in the region have developed near major rivers, so surface water diversions are a key component of municipal water supplies. However, the Sacramento Valley is also recognized as having one of the foremost groundwater basins in the state. The availability of abundant groundwater supplies under the valley floor has allowed urban areas to expand delivery capabilities by including the use of groundwater. In some areas, groundwater has become the principle source of water supply for urban as well as rural domestic uses.

In-stream flows, refuges and wildlife areas are the principal environmental use of water in the region. With the federal and state listing of the spring-run Chinook salmon, winter-run Chinook and Central Valley steelhead, much attention has been given to the recovery of these species and their related habitat. Tributaries to the Sacramento River, as well as the main stem itself, have been the focus of a number of ecosystem-related projects designed to increase the amount of environmental water use for habitat and species restoration.

In addition, the Sacramento Valley serves as a breeding and resting ground along the Pacific Flyway. Therefore, in more recent years, duck and other waterfowl habitat development in the valley section by duck clubs, non-profit groups and natural resource agencies have resulted in an increase in the use of environmental water in an attempt to increase the numbers of waterfowl species residing in or using the region. Certain agricultural practices are known to benefit many species of wildlife. The programs that provide the most benefits are the rice straw decomposition program and the use of agricultural return flow to refuges and duck clubs, which are designed to improve air and water quality in the valley. As a result of these programs, and other resource management activities, the Sacramento River region contains the largest and most extensive wetlands in the state. The Sacramento River region has a number of acres in both private and public ownership dedicated to managed wetlands. For example, in the northeastern mountain counties, associated with the Pit River system, such as the Big Valley and Alturas area, there are about 14,000 acres of managed wetlands. Farther south, in the Sacramento Valley, there are 16,987 acres in federal ownership; 11,987 acres of state lands; and 28,642 acres in private ownership managed as wetlands.

With the listing of the winter-run Chinook, spring-run Chinook salmon and Central Valley steelhead, much of the water diverted out of the Sacramento River waterways for agricultural use, environmental uses and refuge water supplies passes through state-of-the-art fish screens. These fish screens minimize take of the species when water is diverted from the river, and also increases system flexibility, allowing year-long diversion of water for agricultural purposes.

### Current Situation

Table 6-2 presents a Water Supply Balance for this hydrologic region for 1998, a wet year; 2000, an average year; and 2001, a dry year. The total sources of all water supplies to the region are tabulated in the top portion of Table 6-2, the major uses of all water are shown in the middle section, and estimated interaction with groundwater storage is shown at the bottom of the table. Using 2000 as an example, a significant portion of the precipitation (57 million acre-feet) is used by native vegetation (forests), evaporation, unregulated runoff and percolation to groundwater, tabulated as 24.2 million acre-feet. Statutory Required outflows to maintain Delta water quality requirements (SWRCB Decision 1630) are the next largest component of water use, 12.3 million acre-feet, followed by consumptive use of applied water in the Sacramento River region, 5.56 million acre-feet, and water exports to other regions 5.12 million acre-feet. Table 6-4 provides more specific information about the developed or dedicated component of water supplies for agricultural, urban and environmental purposes, as assembled from actual data for 1998, 2000 and 2001. This table provides more specific information regarding the distribution of developed water, with large components used for environmental and agricultural purposes. Figure 6-5 presents a bar chart that summarizes only the dedicated and developed urban, agricultural and environmental water uses in this hydrologic region. Note that the environmental water use component of this Table includes the amount required to maintain Delta outflow standards, which amounts to more than half of the tabulated environmental water usage.

## State of the Region

The 30 percent of the region's lands irrigated with groundwater generally enjoy a reliable supply as do those urban areas that depend on groundwater as all or part of their supply. However, groundwater development in fractured rock sources are highly variable in terms of water quantity and water quality and are an uncertain source for large-scale residential development. In the more rural portions of this region, small, widely dispersed populations translate into high per capita costs for municipal water system maintenance and improvements. Historic development pattern of small geographically dispersed population centers can constrain the ability to interconnect individual water systems or to develop centralized sources of good quality municipal water supplies because major capital improvement projects become more expensive.

Exports from the Sacramento Valley are a concern for some water interest groups in the region, many of which are fearful of losing this resource considered a key component to future economic growth. Although is seems that there is an abundance of supply in this hydrologic region, infrastructure in the foothill communities is limited and water development has historically been built to meet the needs of the downstream urban and agricultural users, resulting in some outlying and foothill areas being subject to supply shortages in many years. The unusual water problems of the foothills are described in more detail in Chapter 12 on the Mountain Counties region. Urban areas in the central part of this region generally have sufficient supplies to survive dry periods with periodic cutbacks. However, as future population growth increases in the region, the competition for high quality water for municipal water will also increase.

Many north valley water users are also concerned that in the future their surface water rights may be further curtailed, such that more groundwater will be needed for irrigation as well as for urban use. In this light, they are apprehensive about new proposals involving the export of surface and groundwater supplies to other locations, unless proper planning provides assurances for retaining the water necessary to meet future agricultural, urban and environmental needs at the local level.

It is anticipated that such changes in surface water allocation in the region will probably occur with negotiations for renewal of CVP contracts, increased environmental restoration, expanded conjunctive use of surface and ground water, and various proposals and designs for water transfers. Cumulatively, these changes could stimulate a substantial increase in groundwater use in the region. In addition groundwater development will most likely be targeted to meet a significant share of the moderately increasing water demands of the region. In response to this phenomenon, some local governments in the region are investigating imposing strict groundwater regulations for new development to assure adequate supply for future needs.

The potential for developing new supplies from groundwater is most favorable in the northern portion of the Sacramento Valley. The southern portion is already experiencing localized groundwater supply and quality problems, such as in the Sacramento area. Although substantial groundwater can potentially be identified in the Sacramento Valley, there is still a great deal of research that needs to be done to evaluate the quantity and quality of these supplies. In the event that additional groundwater supplies are identified and confirmed through scientific methods, much of the existing groundwater infrastructure would have to be replaced or modified to use the resource to its fullest. Moreover, additional groundwater use in the Sacramento Valley has the potential to decrease accretions or deplete river and tributary flow, which may have negative environmental impacts.

Competition for use of the groundwater resource is expected to continue as population increases, and the potential also exists for an increased number of water transfers in the future. Water transfers, especially those contracts with a groundwater substitution component, need to be evaluated for their cumulative effects, because the overall effect could contribute to greater use of the groundwater resources in the region that may negatively impact local water users.

In recent years, requirements for managing threatened and endangered species are influencing management of the region's water supplies. The salmon and steelhead fishery in the upper Sacramento River has declined greatly over past decades, resulting in many programs and projects for fishery restoration. Along the Sacramento River, factors that contribute to this problem include: unsuitably warm water temperatures, toxic heavy metals from acid mine drainage, pesticides and fertilizer runoff, degraded spawning gravels, obstructions to fish migration, and prior loss of riparian habitat due to growth or noxious weed encroachment. It should be noted, however, that some riparian habitats are now being restored due to projects funded by federal and State agencies associated with CBDA (discussed later in this chapter).

In summary, the majority of the region does enjoy abundant groundwater and surface water supplies for all beneficial uses in the region. However, precautions should be taken with land use changes that may use a greater amount of the natural resources because the majority of the area is just beginning to understand its groundwater resources and how they, combined with surface water supplies, can be used most efficiently.

## Challenges

### *Water Reallocation and Transfers*

During extended periods of drought, water districts in the Sacramento River Region that are reliant on surface water supplies may be faced with insufficient water supplies, due to surface water allocation cutbacks imposed by their CVP and SWP water contracts. As shown in Table 6-4, CVP deliveries to this region in a normal year exceed 2.4 million acre-feet per year, while SWP deliveries in the Feather River service area average about 15,000 acre-feet per year. During extended droughts, reductions in deliveries could eventually force water users to choose between using groundwater to replace the reduced surface supplies, or taking valuable agricultural acreage out of production. The additional use of groundwater supplies by a greater number of water users during droughts may result in adverse impacts to the groundwater resource, which has the potential to negatively impact users that are totally dependent on groundwater supplies. Surface water transfer programs to other regions are of concern, because such programs have the potential to aggravate overuse of the groundwater resources. Before new out-of-basin water transfers are considered, local water interests would like to ensure that their existing surface water rights are protected, and that equitable use of groundwater supplies are established to sustain the local agricultural economy and natural resource needs.

With a growing demand for high quality water throughout the state, water transfers are being evaluated more closely as a means to move water out of the Sacramento River region to other parts of the state. In response, several counties in the region have passed laws that regulate or impede water transfers that would move water outside of their county, especially when a proposed transfer program has a groundwater component. In some counties, for instance, transferees are required to mitigate for third-party impacts associated with this type of water transfer and transfers require a permit approved by the Board of Supervisors or its designee. In other counties, transferring groundwater outside of the county is prohibited by local ordinances.

### *Water Quality*

Surface water quality in the watershed is generally good, making the Sacramento River one of the most desirable water sources in the state. Nonetheless, turbidity, rice pesticides, and organophosphate pesticides such as diazinon affect fisheries and drinking water supplies. The decline of fisheries in the Sacramento River is in part related to water quality problems on the river’s main stem: unsuitable water temperature, toxic heavy metals, such as mercury, copper, zinc, and cadmium from acid mine drainage, pesticides and fertilizer in agricultural runoff, and degraded spawning gravels. Holding of rice field drainage, allowing for degradation or rice herbicides, has effectively addressed this water quality concern among downstream water users, in particular, the city of Sacramento. In the Cache Creek watershed, Clear Lake suffers from large mercury, sediment, and nutrient loadings, the latter leading to nuisance algae blooms. Along with a few select other water bodies, the basin plan specifically prohibits direct discharges of wastes into Folsom Lake and the lower American River downstream to its confluence with the Sacramento; waste discharges from houseboats on Shasta, Clear Lake, and in the Delta are also banned. High density recreation use of Whiskeytown and Shasta lakes may be contributing to high bacteria levels in these two reservoirs.

In its triennial review, the Central Valley Regional Board identified mercury loads, a legacy of California’s gold mining heritage, as one of the most significant water quality problems in the region. In particular, the Cache Creek watershed is the major source of mercury to the Delta; to a lesser extent, mercury is also a concern in Lake Berryessa and Marsh Creek Reservoir. An organic form of mercury, methylmercury, is a neurotoxin that is especially dangerous to fetuses and infants, attacking the central nervous system and causing an array of developmental and other problems. Because of methylmercury's bioaccumulative properties, several water bodies in the Sacramento River region have fish consumption advisories. Pesticide management and agricultural water discharge has recently come into the limelight with the Central Valley Regional Water Quality Control Board's decision to eliminate waivers associated with agricultural discharge. Coalitions in the region are forming partnerships to address this issue through a watershed approach as provided for by the Regional Board and affirmed by the State Water Resources Control Board in their review of the Irrigated Lands Conditional Waiver. Stakeholders in the region are working to find a solution that encompasses the protection of public health, meets current and future water quality regulations, and allows for a sustainable agricultural economy.

Groundwater quality in the Sacramento River Region is excellent, though there are local groundwater problems. Naturally occurring salinity impairs wells at the north end of the Sacramento Valley. Groundwater near the Sutter Buttes is impaired because of local volcanic geology, and hydrogen sulfide is a problem in wells in the geothermal areas in the western part of the region. Human-induced impairments, like nitrate, are generally associated with agriculture and septic tanks; the latter is especially an issue in Butte County, where 150,000 of its 200,000 residents rely upon individual septic systems. Septic tanks are often inappropriately sited in shallow, unconfined or fractured hard rock aquifers, where insufficient soil depth is available for necessary leaching. Heavy metals from historical burn dumps also contaminate groundwater locally. In the Sierra foothills there is potential for encountering uranium- and radon-bearing rock or sulfide mineral deposits containing heavy metals. Perchlorate, previously used as an oxidizer or booster for solid rocket fuel and now a human health concern in domestic water, has contaminated wells in Rancho Cordova, near Sacramento.

## Accomplishments

The goals and objectives of the CBDA program play a prominent role in regional efforts to improve water supply reliability, water quality and ecosystem restoration. Current activities and accomplishments are summarized in the following sections.

### *Water Supply Reliability*

Past concerns with potential groundwater exports have spurred numerous counties to enact groundwater ordinances to regulate groundwater extraction when groundwater is intended for export outside the county. In addition, some counties are also involved in extensive cataloging and inventory projects to determine the extent of their water resources and unmet needs of the region to ensure that current and future needs are met locally prior to water exports.

In addition, regional representatives are working in conjunction with CBDA to conduct an extensive reevaluation of additional off-stream surface storage reservoirs in this region designed to store excess water during high flow events and thereby, help alleviate pressure for water exports from the region. Water use efficiencies in the region could provide benefits to other regions of the state if the storage and conveyance capacity existed to hold and transport water when it is needed. This process, commonly known as the North of Delta Off-Stream Storage (NODOS) is evaluating previously identified sites for their suitability in this type of project. Specifically, the Department of Water Resources is conducting an environmental evaluation of the Antelope Valley on the west side of the Sacramento River, near Maxwell for the construction of off-stream storage currently known as Sites Reservoir.

### *Water Use Efficiency*

Water use efficiency in the Sacramento Valley is included in a comprehensive and integrated program being pursued by the agricultural diverters in the region. Most water losses in the region are "recoverable," which means that water returns to rivers and streams where it can be re-used by downstream diverters. Because of this, local incentives to improve water use efficiency are focused on the benefit of decreased operational costs. Water users have accomplished many water saving improvements, including laser-leveling of fields to decrease water consumption and the lining of canals to reduce seepage losses. DWR's Water Use Efficiency program uses grant funding to provide incentives to water users in the Sacramento Valley to develop system improvements that will make water available for uses that provide statewide benefits. These benefits include improving endangered species habitat and improving overall water quality throughout the system by improving source water quality.

The recent development of the Sacramento Valley Water Management Program (SVWMP) can provide a framework for improved regional coordination of water use efficiency in the Sacramento Valley. A regional approach to water use efficiency allows for the coordination and consolidation of individual efforts into a comprehensive plan that optimizes limited financial and water resources. The CALFED Bay-Delta Program, particularly the approach to the regional Quantifiable Objectives (QOs) articulates this regional approach to water use efficiency activities. Additionally, the AB 3616 Program, and the Central Valley Project Improvement Act (CVPIA) Water Conservation Standards could be incorporated to develop a unified regional approach to water use efficiency for the Sacramento Valley. In the SVWMP, the consolidated water use efficiency program would be able to coordinate with other program elements to better meet local needs (water user and environmental) and potentially provide water for other areas of the state.

Agencies involved in CALFED's Water Use Efficiency Program, including DWR, have accomplished the following results through Year 3 of the California Bay Delta Program:

- Partnerships forged for groundwater planning with local agencies in six areas.
- Work initiated on 22 groundwater management and groundwater storage projects.
- Progress made on studies for potential north-of-Delta off-stream storage and Shasta Dam enlargement. The proposed projects are among five surface storage options being studied to increase storage capacity and provide flexibility to the state's water system.
- $11 million in grants awarded for agricultural and urban water use efficiency programs.
- Key achievements made on streamlining water transfers and facilitating transfer agreements that protect local water users, economies and ecosystems.

### *Ecosystem Restoration*

Prior to the Gold Rush of the late 1840s, the area known as the Sacramento Valley consisted of a warm and abundant natural environment, essentially a floodplain to the expansive Sacramento River, rich in natural habitats, such as oaks, sycamore and cottonwood. As the Gold Rush subsided, those it brought to California moved into the plains of the Sacramento Valley and began ranching and farming, clearing the land for these purposes. As the population bases increased in the valley, flood control projects and levees were created in an attempt to control the great river to the detriment of the natural processes of the river and the species that inhabited it. The CBDA Ecosystem Restoration Program attempts to return some of these natural functions to the creeks and rivers in the region to aid in the restoration and maintenance of the endangered species that once inhabited it.

Many ecosystem restoration programs and projects are under way in the Sacramento River region. Some of these projects are along the main stem of the Sacramento River and others involve work along or in the tributaries. CBDA Ecosystem Restoration and Watershed Programs in the Sacramento River region have focused on protecting and restoring habitat for threatened and endangered species, such as salmonids and other fish species and wildlife. Ecosystem protection and restoration on tributaries of the Sacramento River, as well as the main stem, will help to provide habitat for these species while also maintaining water quality in the source area streams that eventually flow into the Bay-Delta.

The Sacramento Valley with its alluvial soils, abundant water and moderate climate, is one of the richest agricultural regions on earth. These same physical attributes also make it an incredibly productive ecosystem that supports more than 250 species of fish and wildlife. For example, spring-run Chinook salmon swim in from the Pacific and climb 5,000 vertical feet, first through the Sacramento River and then Mill Creek, to spawn at the base of Lassen Peak. Canada geese fly from north of the Artic Circle to winter in the wetlands, and Swainson hawks migrate from as far south as Argentina to reach the biologically-rich Sacramento Valley.

During the past 130 years, more than 95 percent of the valley's historic riparian forests have been converted to other land uses. In 1988 federal and state agencies, along with interested stakeholders and regional and local nonprofit groups, began to stabilize this trend by protecting and restoring riparian habitat along the Sacramento River. To date, more than 20,000 acres have been protected in such areas as the Sacramento River National Wildlife Refuge, the Bureau of Land Management's lands north of Red Bluff, Sacramento River State Wildlife Area, other state parks in the region and various areas under private conservation ownership. In addition, about 4,000 acres of flood-prone agricultural land has been restored to riparian forest.

In 1986, the Legislature enacted Senate Bill 1086, which called for development of a riparian habitat inventory and created the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The purpose of this plan is to preserve remaining riparian habitat and reestablish a continuous riparian ecosystem along the Sacramento River. The final plan contained a conceptual Riparian Habitat Restoration Plan to guide riparian habitat restoration along the river and its major tributaries from Red Bluff to Verona. An advisory board with representation appointed by the appropriate local governments was established. This body evolved into the Sacramento River Conservation Area Forum (SRCAF) in 1999. Each of the seven counties bordering the river in this region has a public interest and a landowner member serving on the forum board. The board meets monthly to help guide activities that take place along the river.

The management plan for this program also contained a more specific Fishery Restoration Plan, listing 20 actions to help restore the salmon and steelhead fisheries of the river and its tributaries. All of the proposed restoration is now under way, funded by a combination of federal, State, and local sources. The Central Valley Project Improvement Act of 1992 (CVPIA) includes many of the CVP related fishery restoration measures recommended by the SB 1086 plan.

One of the concerns expressed by regional stakeholders involves land acquisitions for restoration projects that may not allow for reimbursement of tax dollars to local governments for land conversion projects. Local governments fear that the loss of revenue from productive agricultural land taken off of the tax roles may affect their ability to provide health and safety in their jurisdictions. In response to this concern, since 2000, the CBDA has begun using conservation easements rather than direct purchases. This approach leaves the property on the tax roles, thus minimizing the negative impacts associated with land conversion.

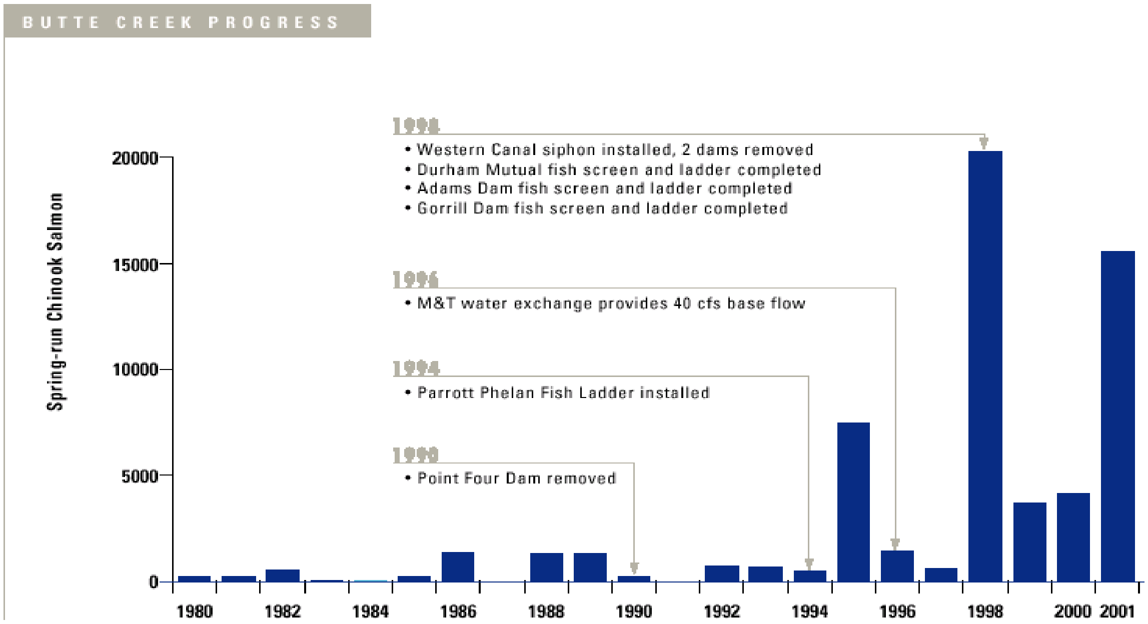
Local governments would also like to see programs that provide for species recovery and protection which support reasonable recreational access for the public that would contribute to an increase in tourism dollars in the local economy. It is anticipated that increased recreation associated with a healthier river system will contribute to the local economy in the future.

SRCAF participants are hopeful that the discussions that take place at the SRCAF, as well as its associated subcommittees, will address some of the concerns expressed above. One of the guiding principles of the program is to give full consideration to landowner, public and local government concerns. It is felt that to ensure that true system-wide planning is effective, the planning must include participation by local government, environmental groups and agencies along the river. The SRCAF provides the opportunity and encourages this type of participation.

The Sacramento River region is the focus of significant CBDA ecosystem restoration through several different sources, including local efforts, CVPIA and CBDA, and many more are planned for several decades including species recovery of fish. The CALFED Multi-species Conservation Strategy (MSCS) is a comprehensive regulatory plan for the CALFED Program developed in accordance with the federal Endangered Species Act (ESA), the California Endangered Species Act (CESA), and the Natural Communities Conservation Planning Act (NCCPA). The MSCS establishes the State and federal regulations for numerous species and habitat types throughout the focus area. By adhering to this plan, the program can comply with these regulating acts.

Increased concern over the decline in endangered salmon has stimulated several projects and programs in the region over the past several years designed to alleviate pressures on these fish. Significant work has been accomplished toward this end on Butte Creek, for example. Partnerships between landowners and agricultural water districts along the creek and State and federal agencies have resulted in the removal or reengineering of several small dams, the screening of diversions from this creek, and the construction of a canal siphon beneath Butte Creek to aid in fish passage for spawning and rearing. These partnerships resulted in the removal of the Western Canal, McPherrin, McGowan, and Point Four Dams and screening modification or construction on five other diversions along this tributary. These efforts, that have been coordinated and partially funded through CBDA, have built strong partnerships in the valley between agencies and landowners. They have also contributed to an increase in the returning runs of spring-run Chinook salmon up to their highest level in several years. These numbers are displayed in the following chart through 2001 (Figure 6-1). Data collected from the 2002 and 2003 carcass counts indicate a continued high level of returning spawning populations.

**Figure 6-1**
**Butte Creek Progress**




Another major salmon recovery project in the Sacramento River region is on Battle Creek. The Battle Creek Restoration Program proposes to restore access for salmon and steelhead to about 42 miles of habitat in the north and south forks of Battle Creek while minimizing the loss of clean and renewable energy provided by PG&E's Battle Creek Hydroelectric Project. This project includes removal of up to five diversion dams, construction of ladders and fish screens at three additional diversions and increasing flow releases from remaining diversion dams. Environmental documents for the project are under development and a proposal for additional funds is under review by the Ecosystem Restoration Program. PG&E is the majority landowner in the project area, and is working with the Bureau of Reclamation, USFWS, NOAA Fisheries, Department of Fish & Game under a Memorandum of Understanding signed in 1999. They are working closely with the Battle Creek Working Group that includes the Battle Creek Watershed Conservancy, other CALFED agencies and other interested parties.

A third example of restoration in the Sacramento River region lies on Clear Creek, which is also a tributary to the Sacramento River, near Redding in Shasta County. Restoring Clear Creek is identified in several significant documents or act of legislation, including CVPIA, Section 3406, (b)(12). Through increasing flows in the creek by releasing more water from Whiskeytown Dam; the removal of McCormick-Saeltzer Dam in 2000; supplementing the gravel supply, which was blocked by Whiskeytown Dam; implementing methods to control erosion having negative impacts to salmonid habitat; and restoring the stream channel the Clear Creek Restoration Program has contributed significantly to the five-fold increase in fall Chinook spawning escapements in Clear Creek from 1995 to 2002 over the baseline period of 1967 to 1991. Data also show trends of increases in steelhead and spring-run Chinook spawning and juvenile production.

Another major salmon recovery effort in the Sacramento River Region is the implementation of the CVPIA Anadromous Fish Screen Program. This program has partnered State and federal agencies with water diverters in the region to develop and implement fish screen projects for the large and significant diversions on the Sacramento and other rivers in the regions. As a result of this program, almost all of the water diverted from the Sacramento River is pumped through state-of-the-art fish screens. This program has increased the flexibility of diversions from the river, allowing diverters to increase deliveries to wildlife refuges, increase the acres of habitat for migratory waterfowl using the Pacific Flyway, and implement a valleywide rice straw decomposition program that replaces the traditional practice of burning rice straw. As a result of these efforts, the Sacramento Valley is seeing increases in anadromous fish populations without infringements on diversion rights.

In addition to the projects discussed above, another program under the ERP which is active in the region is the Environmental Water Program (EWP). The goal of this program is to identify and purchase 100,000 acre-feet of water annually to augment in-stream flows north of the Delta. Four of the five Tier 1 priority streams for the program lie in the region: Clear Creek, Mill Creek, Butte Creek and Deer Creek. The EWP is also working closely with Battle Creek, which has been identified as a Tier 2 priority stream in this program. Development of a regional implementation structure for the Ecosystem Restoration Program Plan that is consistent with and in collaboration with existing local restoration program integration efforts is vital.

There are currently numerous watershed groups in the region compiling valuable data and involved in restoration projects in their watersheds. However, these are only a piece of the larger fabric of the greater Sacramento River watershed. Efforts are continuing to provide a comprehensive view of the watershed based on information gathered from funded projects throughout the watershed. This will allow for more informed decision-making and better protection and use of the resources.

Through Year 3 of the CBDA Program, the Ecosystem Restoration Program (ERP) and CALFED Watershed program have provided funding to the Sacramento Valley region as follows:

- $172 million invested in 139 local ecosystem restoration projects. Funded projects, including more than 50 projects to improve fish passage, restore habitat, monitor and assess watersheds, and provide education and outreach.
- $11.4 million invested in 40 local watershed projects addressing areas such as spawning gravel, floodplain management and watershed education and outreach.
- $12 million provided for studies addressing mercury and other pollutants associated with abandoned mines.

## Looking to the Future

Water agencies in the region continue to manage water in light of changing conditions in the region and the state. An example is the Sacramento Valley Water Management Program (SVWMP). This resource management program was established as an alternative to SWRCB Phase 8 litigation proceedings designed to determine the responsibility of meeting water quality standards in the Delta. This agreement allows the parties to collaborate in the development and implementation of a variety of water management projects that will increase the availability of Sacramento Valley water. The agreement provides that increased supplies will be used first to fully meet the in basin needs, but would also be made available to help meet the requirements of the 1995 Water Quality Control Plan, provide other environmental benefits, and potentially meet additional export needs.

The key to this program is to keep it focused on integrated regional planning. SVWMP hydrologists and engineers are involved in more than 50 projects into both short- and long-term work plans for the region.

These projects are designed to protect Northern California surface water rights and groundwater basins through the implementation of groundwater planning and monitoring that provides for unmet demands in the Sacramento Valley before exporting water to other regions. They include system improvement and water-use efficiency measures, conjunctive management, and surface water reoperation projects that include groundwater protection elements. The SVWMP is based on local control. This program is undergoing an environmental review and will seek public funds, including Proposition 50, to help implement many of these projects.

In addition to the Sacramento Valley Water Management Program, several other entities are working to improve water supply reliability and quality in the region and throughout the state. For example, the Redding Area Water Council is considering local water transfers, conjunctive use of groundwater, groundwater management, and additional surface water developments to increase supplies.

The Regional Water Authority is a joint powers authority that represents the interests of nearly 20 water providers around Sacramento. The organization's mission is to help its members protect and enhance the reliability, availability, affordability and quality of water in this area of the region.

The Sacramento Water Forum has developed a Water Forum Agreement containing two, equal objectives: 1) provide reliable and safe water for the region's economic health and planned development through 2030; and 2) preserve the fishery, wildlife, recreational and aesthetic values of the lower American River. The proposed draft solution includes an integrated package of seven actions. Generally, foothill water interests would increase their diversions from the American River in average and wet years and decrease those diversions in drier and driest years. Placer County Water Agency would be providing excess water from non-American River sources to many of the participating water agencies during drier and driest years to help make up the decreased American River diversions in those years.

The Sacramento Valley Water Quality Coalition (SVWQC) was formed in 2002 to enhance and improve water quality in the Sacramento River watershed (Sacramento River Basin, Region 5a), while sustaining the economic viability of agriculture, functional values of managed wetlands and sources of safe drinking water. This group is comprised of more than 200 agricultural and wetlands interests that have joined with local governments throughout the region to improve water quality for Northern California farms, cities and the environment.

In response to the Central Valley Regional Water Quality Control Board's recent decisions to revise agricultural water discharge waivers, the SVWQC developed and submitted its Regional Plan for Action to both the SWRCB and the Regional Water Quality Control Board in June 2003. This plan was submitted as the SVWQC's General Report with its Notice of Intent (NOI) to meet the newly adopted water quality regulations. On Feb. 10, 2004, the Regional Board issued a Notice of Applicability (NOA) to the SVWQC verifying the NOI. As the next step to implement this SVWQC Plan and to meet the Regional Board's regulations, two documents were prepared and submitted on April 1, 2004, a Watershed Evaluation Report (WER) and a Monitoring and Reporting Program Plan (MRP). When approved by the RWQCB, these documents are intended to become the foundation for a rational, phased water quality management program.

Another recently formed group in this region is the Sacramento Valley Environmental Water Caucus, which is interested in developing long-term coordinated water management programs to restore the environmental habitat and natural processes of the entire watershed, in ways that promote compatibility with recreation and land use planning. This group hopes to develop region-wide consensus and stakeholder support to promote clean and reliable groundwater, water for environmental habitat and its recreational benefits, and adequate water resources to meet all future needs in the region.

## Changes in Water Demands for 2030 Scenarios

To illustrate the general magnitude of future changes in urban, agricultural, and environmental water demands, DWR prepared preliminary estimates of average-year water demands for each of the three example 2030 scenarios. As described in Chapter 3 of Volume 1, these three future scenarios are identified as Current Trends, Resource Efficient and Resource Intensive. The Volume 4 Reference Guide includes a description of the methods and assumptions used to produce these estimates in "Analytica-based Scenario Water Demand Estimation."

Scenario demand estimates were made individually for the urban, agricultural, and environmental sectors for each of the 10 California hydrologic regions. DWR staff assigned a unique set of input values for each scenario to reflect the qualitative narrative descriptions and scenario factors in Table 3-1 of Volume 1.

For the Sacramento River hydrologic region, the combined (or net) change in scenario water demands for average water years is shown in Figure 6-6Y. These scenario water demand changes are shown relative to year 2000 total water uses.

As previously stated, these projections are preliminary estimates of plausible future demands, which were developed without consideration of water supplies and delivery capabilities. The complex modeling necessary to complete a full analysis of the three described scenarios will be undertaken as the CWP Phase 2 and Phase 3 work.

### Regional Planning and Coordination

Regional coordination of water resource issues and planning in the Sacramento River region is just beginning and will initially focus on fostering regional cooperation and helping regional interests develop programs that are mutually beneficial to the various stakeholders. Efforts will be made to assist the stakeholders by increasing communication between groups in the region and between the region and CBDA programs.

CBDA staff and associated federal, State and local agencies will work closely with Sacramento Valley stakeholders, including those mentioned in preceding paragraphs as well as local elected officials, water district elected officials and staff, public agencies, watershed groups, environmental activists and other interested members of the public. The goal will be to assist regional efforts in the development of regional planning. This strategy will allow local stakeholders to have a voice in activities supported by CBDA through funding in the region. It will also outline how the region will coordinate these activities with other regions throughout the Bay-Delta solution area.

In addition to the regional approach being taken along the Sacramento River through the Sacramento River Conservation Area Forum, other regional endeavors should be encouraged. For instance, in the northern Sacramento Valley, contiguous aquifer systems underlie several counties. As a result, utilization of the groundwater by one county may affect another. Therefore, regional coordination and cooperation is essential for the individual users as well as providing benefits to the region as a whole.

Outreach efforts are contemplated to educate local elected officials and landowners about implementation of the CBDA plan in the Sacramento Valley and provide briefings and announcements on regional activities. The coordination of these activities with local governments and local conservation organizations will help inform the local leaders and build trust.

In addition, several Northern California counties have sought and obtained grant funding through the AB 303 program, and formed working partnerships to help them develop regional groundwater monitoring. AB 303 provides up to $250,000 per project for groundwater monitoring activities, including the drilling of monitoring wells. Both Butte and Tehama County have completed an inventory/analysis of their water resources to assist them in future water planning. Lake County recently applied for funding under AB 303 to do the same. Butte, Glenn, Plumas, Sutter, Shasta, Tehama and Sacramento counties have all moved forward with the development of integrated groundwater management plans. Glenn, Tehama and Butte counties have obtained funding to increase their groundwater monitoring activities through AB 303 grant funding. Several other entities, such as Anderson-Cottonwood Irrigation District, Deer Creek Irrigation District, Glenn-Colusa Irrigation District, Western Canal Water District and Maxwell Irrigation District have all augmented their groundwater monitoring activities in the region as well. Other counties, some non-profit groups, and Resource Conservation Districts (RCDs) in the region have also received funding for major ecosystem restoration and conservation programs through the CBDA program.

## Water Portfolios for Water Years 1998, 2000 and 2001

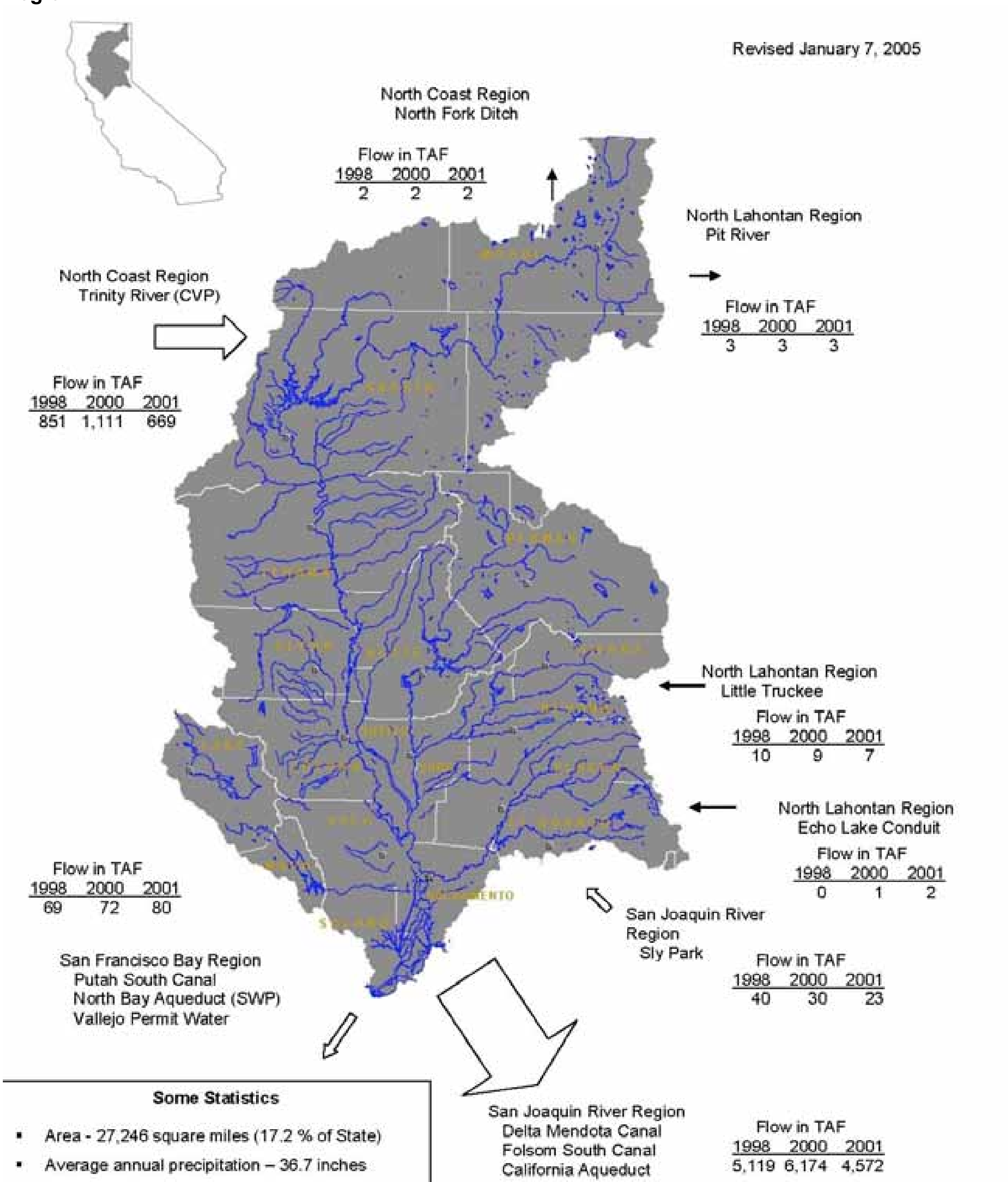
The following tables present actual information about the water supplies and uses for the Sacramento River Hydrologic Region. Water year 1998 was wet for this region, with annual precipitation at 168 percent of normal, while the statewide annual precipitation was 171 percent of average. 2000 represents nearly normal hydrologic conditions with annual precipitation at 105 percent of average for the Sacramento River region, and 2001 reflected dryer water year conditions with annual precipitation at 67 percent of average. For comparison, statewide average precipitation in 2001 was 72 percent of normal. Table 6-2 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports and groundwater, and also summarizes the uses of all of the water supplies. The three Water portfolio tables included in Table 6-3 and companion water portfolio flow diagrams Figures 6-7, 6-8 and 6-9 provided more detailed information about how the available water supplies are distributed and used throughout this region.

A more detailed tabulation of the portion of the total available water that is dedicated to urban, agricultural and environmental purposes is presented in Table 6-4. Because much of the Sacramento River region is devoted to agricultural activities, a large component of the developed water is supplied to agricultural purposes. Dedicated environmental water use is also a large component of the developed water supply, primarily because the required Sacramento – San Joaquin Delta outflow is accounted for in this region. Table 6-4 also provides detailed information about the sources of the developed water supplies, which are primarily from surface water systems of the Sacramento River and its tributaries. The use of available groundwater supplies is also a significant resource to this region.

## Sources of Information


- Water Quality Control Plan, Regional Water Quality Control Board
- Watershed Management Initiative Chapter, Regional Water Quality Control Board
- 2002 California 305(b) Report on Water Quality, State Water Resources Control Board
- Bulletin 118 (Draft), California's Groundwater, Update 2003, Department of Water Resources
- Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000
- Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001
- Hanak, Ellen 2003, Who Should be Allowed to Sell Water in California? Third-Party Issues and the Water Market, Public Policy Institute of California
- Smith, F. 1980. A short review of the status of riparian forests in California. Pages 1-2 in: A. Sands (Editor). Riparian Forests in California. University of California Press, Berkeley, CA.
- Kelley, Robert 1998 Battling the Inland Sea, University of California Press, Berkeley
- U.S.D.A. Forest Service Web site at www.fs.fed.us/recreation/map/state_list.shtml#California
- California Department of Fish and Game (CDFG). 2001. Spring-run Chinook salmon annual report for the Fish and Game Commission.

**Figure 6-2**
**Sacramento River Hydrologic**
**Region**




**Some Statistics**

- Area - 27,246 square miles (17.2 % of State)
- Average annual precipitation – 36.7 inches
- Year 2000 population - 2,593,110
- 2030 projected population – 4,569,490
- Total reservoir storage capacity - 16,146 TAF
- 2000 irrigated agriculture - 2,037,900 acres

**Figure 6-3**
**Sacramento River Hydrologic Region Population**

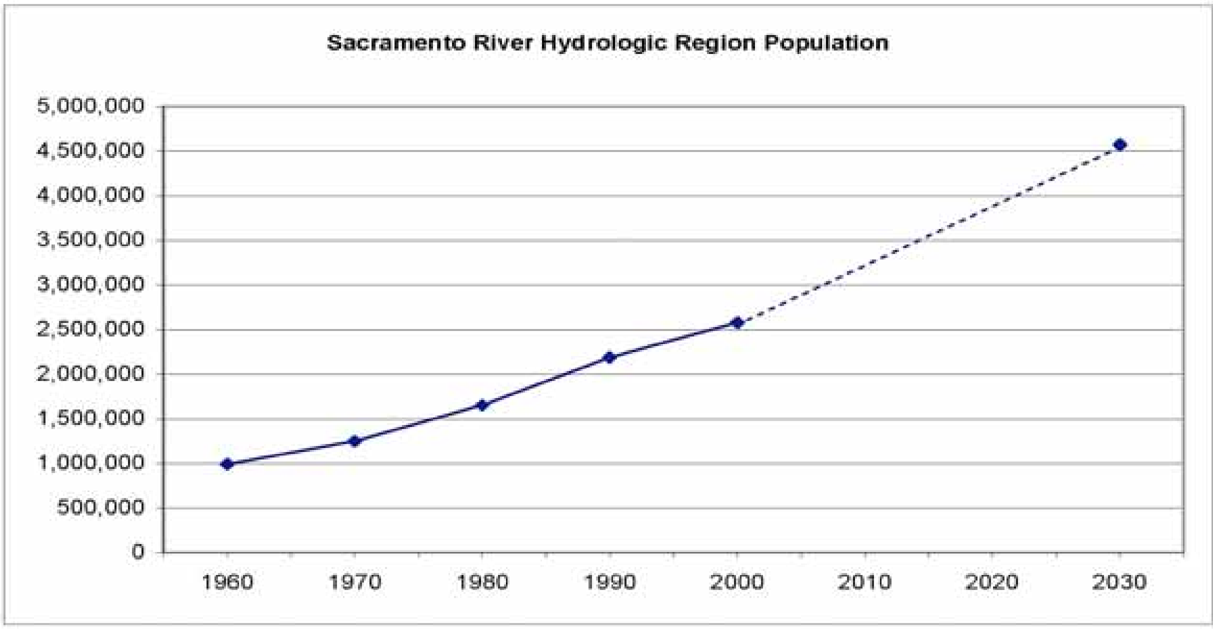


Figure 6-4
Sacramento River Region Dedicated Water Supplies For Water Years 1998, 2000, 2001

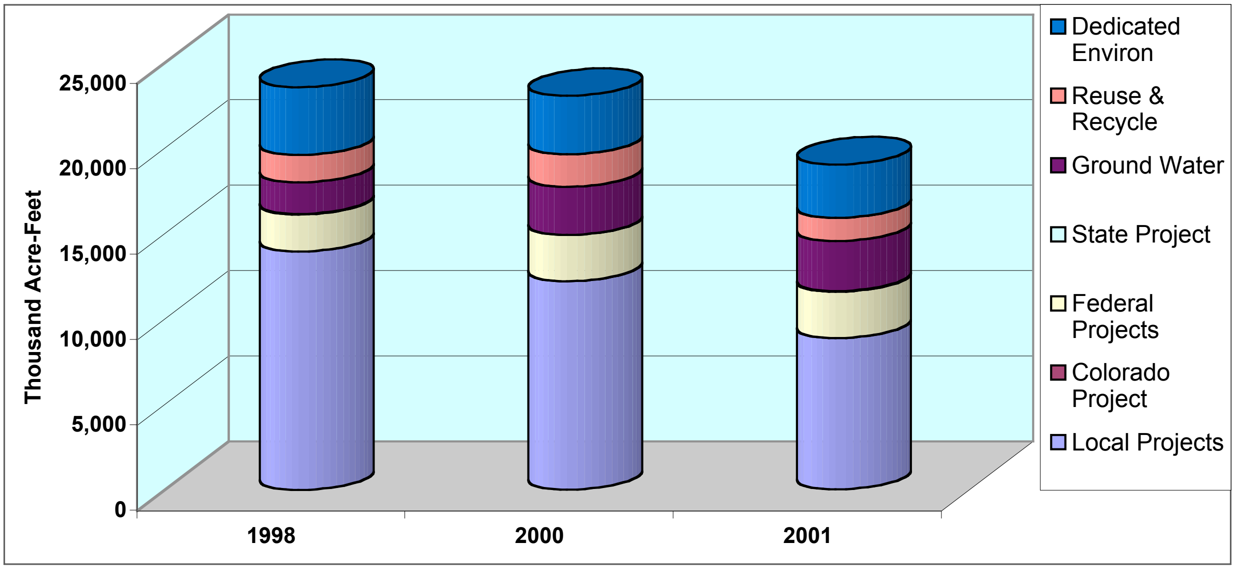



Figure 6-5
Sacramento River Region Applied Water Uses For Water Years 1998, 2000, 2001

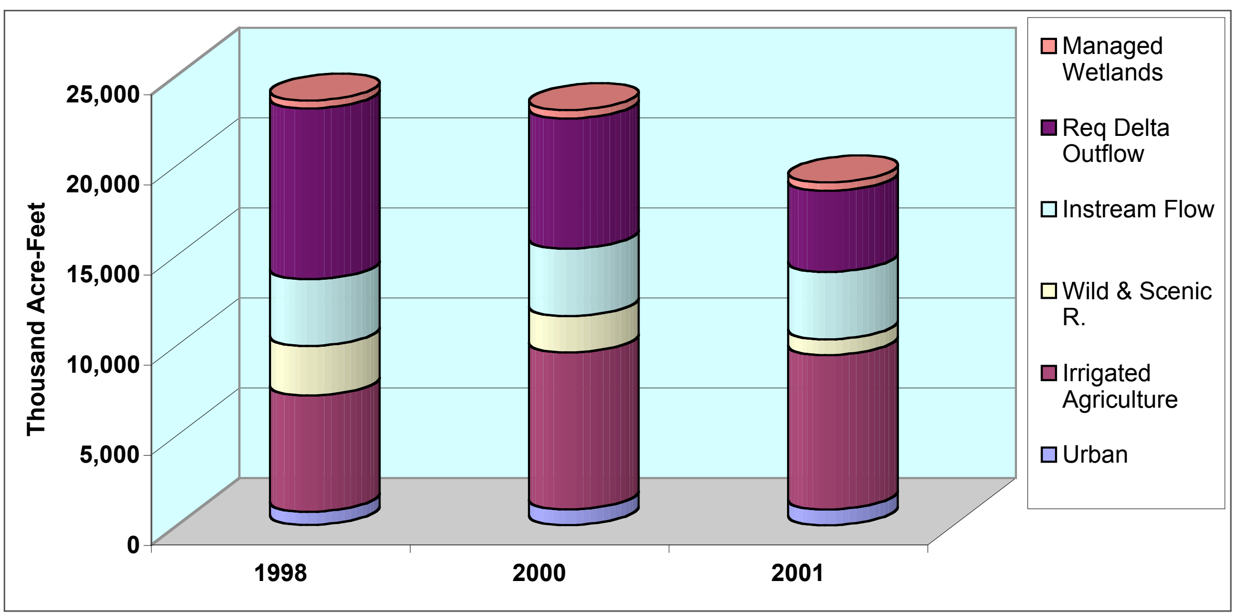


**Figure 6-6**
**Average Year Estimates of Water Demand Changes (2000 to 2030)**

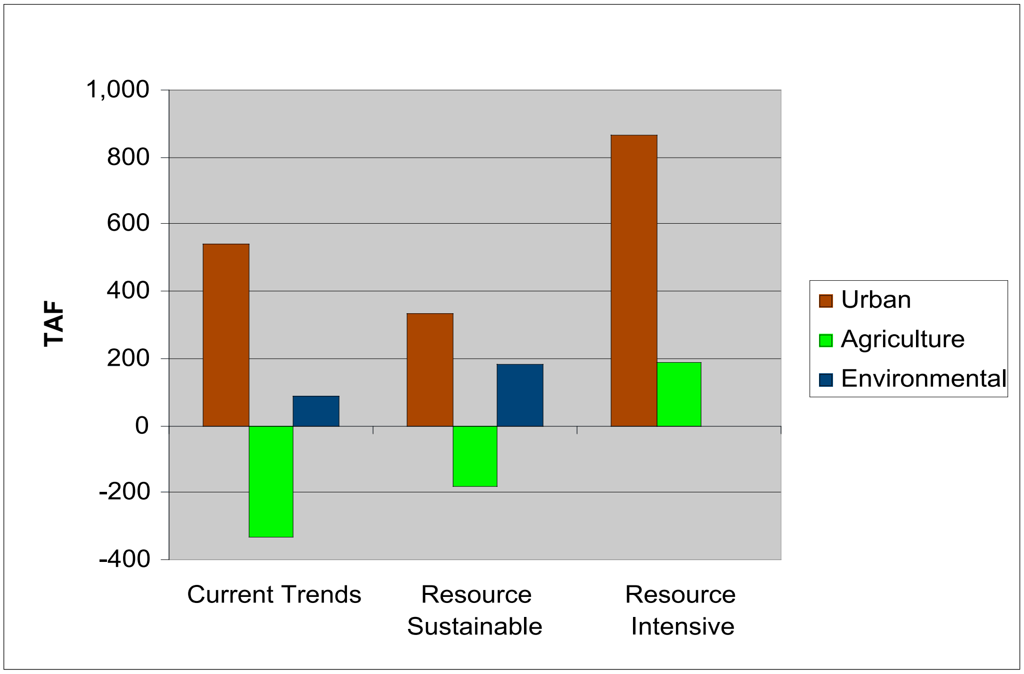


**Table 6-2**
**Sacramento River Hydrologic Region Water Balance Summary – TAF**

Water Entering the Region – Water Leaving the Region = Storage Changes in Region

| | Water Year (Percent of Normal Precipitation) | | |
|---|---|---|---|
| | 1998 (168%) | 2000 (105%) | 2001 (67%) |
| **Water Entering the Region** | | | |
| Precipitation | 89,500 | 57,106 | 35,895 |
| Inflow from Oregon/Mexico | 0 | 0 | 0 |
| Inflow from Colorado River | 0 | 0 | 0 |
| Imports from Other Regions | 851 | 1,111 | 669 |
| **Total** | **90,351** | **58,217** | **36,564** |
| **Water Leaving the Region** | | | |
| Consumptive Use of Applied Water * (Ag, M&I, Wetlands) | 4,119 | 5,532 | 5,456 |
| Outflow to Oregon/Nevada/Mexico | 0 | 0 | 0 |
| Exports to Other Regions | 2,268 | 5,116 | 3,763 |
| Statutory Required Outflow to Salt Sink | 15,002 | 12,301 | 8,796 |
| Additional Outflow to Salt Sink | 35,112 | 12,328 | 3,940 |
| Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows | 30,358 | 24,192 | 18,169 |
| **Total** | **86,859** | **59,469** | **40,124** |
| **Storage Changes in the Region** [+] Water added to storage [–] Water removed from storage | | | |
| Change in Surface Reservoir Storage | 2,752 | -1,101 | -2,412 |
| Change in Groundwater Storage ** | 740 | -151 | -1,148 |
| **Total** | **3,492** | **-1,252** | **-3,560** |

| | | | |
|---|---|---|---|
| **Applied Water *** (compare with Consumptive Use)<br><br>* Definition - Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows. | 6,957 | 9,208 | 9,096 |

**Footnote for change in Groundwater Storage

Change in Groundwater Storage is based upon best available information. Basins in the north part of the State (North Coast, San Francisco, Sacramento River and North Lahontan Regions and parts of Central Coast and San Joaquin River Regions) have been modeled – Spring 1997 to Spring 1998 for the 1998 water year and Spring 1999 to Spring 2000 for the 2000 water year. All other regions and Year 2001 were calculated using the following equation:

**GW change in storage =**
**intentional recharge + deep percolation of applied water + conveyance deep percolation – withdrawals**

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow

## Table 6-3
## Water Portfolios for Water Years 1998, 2000 and 2001 - TAF

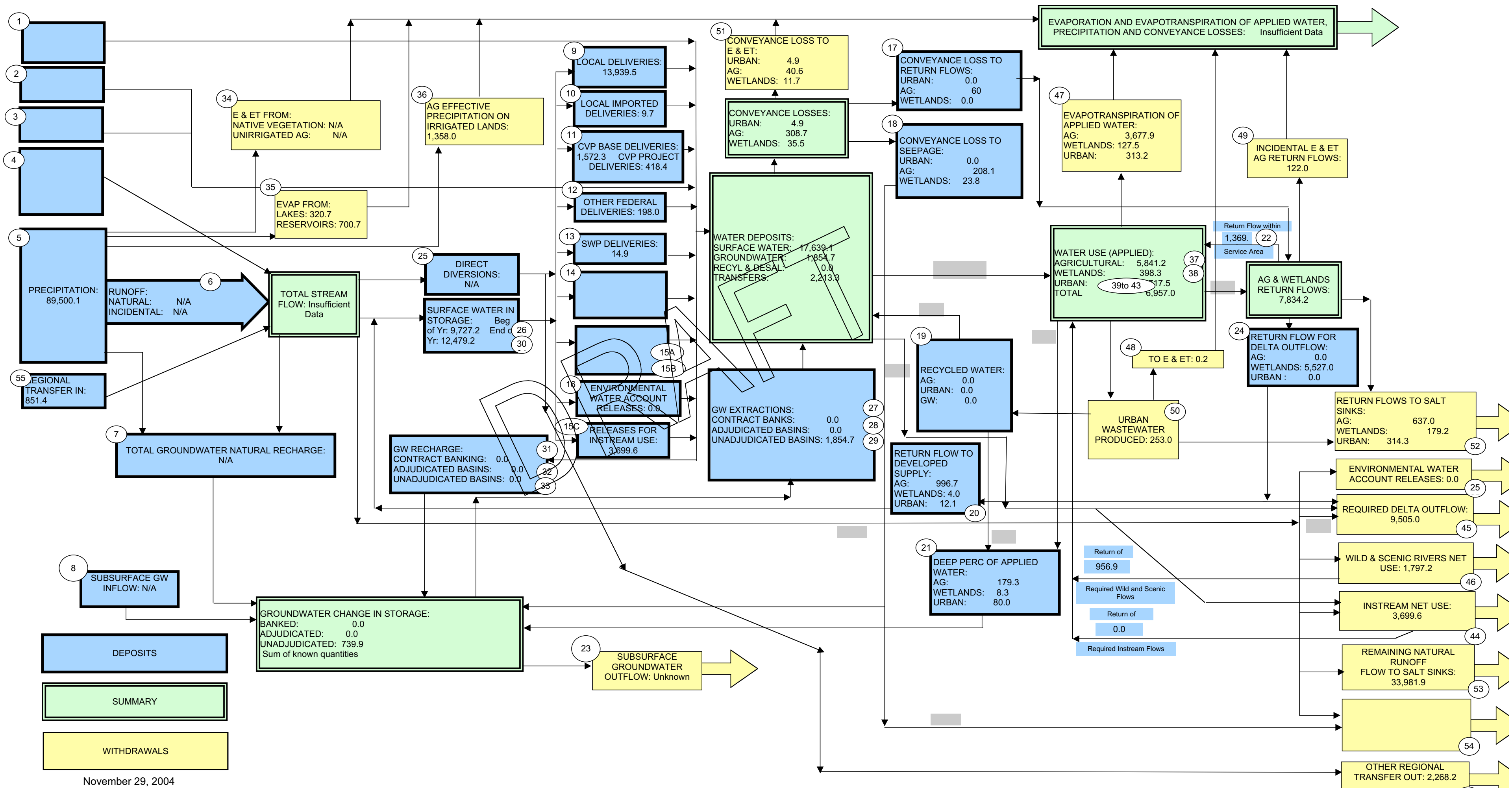
| Category | Description | Water Portfolio | Applied Water | Net Water | Depletion | Water Portfolio | Applied Water | Net Water | Depletion | Water Portfolio | Applied Water | Net Water | Depletion | Data Detail |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inputs: | | | | | | | | | | | | | | |
| 1 | Colorado River Deliveries | | - | | | | - | | | | - | | | PSA/DAU |
| 2 | Total Desalination | | - | | | | - | | | | - | | | PSA/DAU |
| 3 | Water from Refineries | | - | | | | - | | | | - | | | PSA/DAU |
| 4a | Inflow From Oregon | | - | | | | - | | | | - | | | PSA/DAU |
| b | Inflow From Mexico | | - | | | | - | | | | - | | | PSA/DAU |
| 5 | Precipitation | 89,500.1 | | | | 57,105.9 | | | | 35,894.8 | | | | REGION |
| 6a | Runoff - Natural | N/A | | | | N/A | | | | N/A | | | | REGION |
| b | Runoff - Incidental | N/A | | | | N/A | | | | N/A | | | | REGION |
| 7 | Total Groundwater Natural Recharge | N/A | | | | N/A | | | | N/A | | | | REGION |
| 8 | Groundwater Subsurface Inflow | N/A | | | | N/A | | | | N/A | | | | REGION |
| 9 | Local Deliveries | | 13,939.5 | | | | 12,204.8 | | | | 8,843.0 | | | PSA/DAU |
| 10 | Local Imports | | 9.7 | | | | 10.4 | | | | 8.5 | | | PSA/DAU |
| 11a | Central Valley Project :: Base Deliveries | | 1,572.3 | | | | 1,912.9 | | | | 2,002.0 | | | PSA/DAU |
| b | Central Valley Project :: Project Deliveries | | 418.4 | | | | 553.8 | | | | 495.3 | | | PSA/DAU |
| 12 | Other Federal Deliveries | | 198.0 | | | | 228.3 | | | | 239.5 | | | PSA/DAU |
| 13 | State Water Project Deliveries | | 14.9 | | | | 14.9 | | | | 19.6 | | | PSA/DAU |
| 14a | Water Transfers - Regional | | - | | | | - | | | | - | | | PSA/DAU |
| b | Water Transfers - Imported | | - | | | | - | | | | - | | | PSA/DAU |
| 15a | Releases for Delta Outflow - CVP | | - | | | | - | | | | - | | | REGION |
| b | Releases for Delta Outflow - SWP | | - | | | | - | | | | - | | | REGION |
| c | Instream Flow Applied Water | | 3,699.6 | | | | 3,759.8 | | | | 3,747.5 | | | REGION |
| 16 | Environmental Water Account Releases | | | | | | 264.0 | | | | 242.0 | | | PSA/DAU |
| 17a | Conveyance Return Flows to Developed Supply - Urban | | - | | | | - | | | | - | | | PSA/DAU |
| b | Conveyance Return Flows to Developed Supply - Ag | | 60.0 | | | | 44.5 | | | | 45.4 | | | PSA/DAU |
| c | Conveyance Return Flows to Developed Supply - Managed Wetlands | | - | | | | - | | | | - | | | PSA/DAU |
| 18a | Conveyance Seepage - Urban | | - | | | | - | | | | - | | | PSA/DAU |
| b | Conveyance Seepage - Ag | | 208.1 | | | | 273.3 | | | | 271.8 | | | PSA/DAU |
| c | Conveyance Seepage - Managed Wetlands | | 23.8 | | | | 24.5 | | | | 13.4 | | | PSA/DAU |
| 19a | Recycled Water - Agriculture | | - | | | | - | | | | - | | | PSA/DAU |
| b | Recycled Water - Urban | | - | | | | - | | | | - | | | PSA/DAU |
| c | Recycled Water - Groundwater | | - | | | | - | | | | - | | | PSA/DAU |
| 20a | Return Flow to Developed Supply - Ag | | 996.7 | | | | 1,211.2 | | | | 955.2 | | | PSA/DAU |
| b | Return Flow to Developed Supply - Wetlands | | 4.0 | | | | 4.2 | | | | 4.4 | | | PSA/DAU |
| c | Return Flow to Developed Supply - Urban | | 12.1 | | | | 11.8 | | | | 13.1 | | | PSA/DAU |
| 21a | Deep Percolation of Applied Water - Ag | | 179.3 | | | | 299.8 | | | | 320.3 | | | PSA/DAU |
| b | Deep Percolation of Applied Water - Wetlands | | 8.3 | | | | 11.6 | | | | 12.3 | | | PSA/DAU |
| c | Deep Percolation of Applied Water - Urban | | 80.0 | | | | 91.6 | | | | 91.4 | | | PSA/DAU |
| 22a | Reuse of Return Flows within Region - Ag | | 367.6 | | | | 569.2 | | | | 446.1 | | | PSA/DAU |
| b | Reuse of Return Flows within Region - Wetlands, Instream, W&S | | 1,001.4 | | | | 1,019.8 | | | | 619.4 | | | PSA/DAU |
| 24a | Return Flow for Delta Outflow - Ag | | - | | | | - | | | | 227.9 | | | PSA/DAU |
| b | Return Flow for Delta Outflow - Wetlands, Instream, W&S | | 5,527.0 | | | | 4,835.4 | | | | 4,098.4 | | | PSA/DAU |
| c | Return Flow for Delta Outflow - Urban Wastewater | | - | | | | - | | | | - | | | PSA/DAU |
| 25 | Direct Diversions | N/A | | | | N/A | | | | N/A | | | | PSA/DAU |
| 26 | Surface Water in Storage - Beg of Yr | 9,727.2 | | | | 11,603.3 | | | | 10,502.6 | | | | PSA/DAU |
| 27 | Groundwater Extractions - Banked | - | | | | - | | | | - | | | | PSA/DAU |
| 28 | Groundwater Extractions - Adjudicated | - | | | | - | | | | - | | | | PSA/DAU |
| 29 | Groundwater Extractions - Unadjudicated | 1,854.7 | | | | 2,815.2 | | | | 2,926.9 | | | | REGION |
| Withdrawals: | In Thousand Acre-feet | | | | | | | | | | | | | |
| 23 | Groundwater Subsurface Outflow | N/A | | | | N/A | | | | N/A | | | | REGION |
| 30 | Surface Water Storage - End of Yr | 12,479.2 | | | | 10,502.6 | | | | 8,090.8 | | | | PSA/DAU |
| 31 | Groundwater Recharge-Contract Banking | | - | | | | - | | | | - | | | PSA/DAU |
| 32 | Groundwater Recharge-Adjudicated Basins | | - | | | | - | | | | - | | | PSA/DAU |
| 33 | Groundwater Recharge-Unadjudicated Basins | | - | | | | - | | | | - | | | REGION |
| 34a | Evaporation and Evapotranspiration from Native Vegetation | | | | N/A | | | | N/A | | | | N/A | REGION |
| b | Evaporation and Evapotranspiration from Unirrigated Ag | | | | N/A | | | | N/A | | | | N/A | REGION |
| 35a | Evaporation from Lakes | | | | 320.7 | | | | 331.5 | | | | 326.1 | REGION |
| b | Evaporation from Reservoirs | | | | 700.7 | | | | 798.5 | | | | 728.9 | REGION |
| 36 | Ag Effective Precipitation on Irrigated Lands | | 1,358.0 | | | | 1,057.5 | | | | 1,056.6 | | | REGION |
| 37 | Agricultural Water Use | | 5,841.2 | 5,294.3 | 4,297.6 | | 7,927.1 | 7,058.1 | 5,846.9 | | 7,781.7 | 7,015.3 | 5,827.2 | PSA/DAU |
| 38 | Managed Wetlands Water Use | | 398.3 | 345.5 | 311.3 | | 429.5 | 377.4 | 343.0 | | 445.7 | 378.5 | 343.7 | PSA/DAU |
| 39a | Urban Residential Use - Single Family - Interior | | 120.0 | | | | 136.1 | | | | 139.8 | | | PSA/DAU |
| b | Urban Residential Use - Single Family - Exterior | | 224.3 | | | | 267.9 | | | | 273.0 | | | PSA/DAU |
| c | Urban Residential Use - Multi-family - Interior | | 71.5 | | | | 87.2 | | | | 89.4 | | | PSA/DAU |
| d | Urban Residential Use - Multi-family - Exterior | | 19.5 | | | | 23.8 | | | | 24.3 | | | PSA/DAU |
| 40 | Urban Commercial Use | | 113.1 | | | | 140.4 | | | | 137.5 | | | PSA/DAU |
| 41 | Urban Industrial Use | | 77.3 | | | | 84.2 | | | | 84.5 | | | PSA/DAU |
| 42 | Urban Large Landscape | | 91.8 | | | | 111.2 | | | | 120.1 | | | PSA/DAU |
| 43 | Urban Energy Production | | - | | | | 0.3 | | | | 0.1 | | | PSA/DAU |
| 44 | Instream Flow | | 3,699.6 | 3,699.6 | 3,699.6 | | 3,759.8 | 3,759.8 | 3,759.8 | | 3,747.5 | 3,747.5 | 3,747.5 | PSA/DAU |
| 45 | Required Delta Outflow | | 9,505.0 | 9,505.0 | 9,505.0 | | 7,231.6 | 7,231.6 | 7,231.6 | | 4,486.2 | 4,486.2 | 4,486.2 | PSA/DAU |
| 46 | Wild and Scenic Rivers | | 2,754.1 | 1,797.2 | 1,797.2 | | 2,024.7 | 1,045.4 | 1,045.4 | | 885.0 | 320.5 | 320.5 | PSA/DAU |
| 47a | Evapotranspiration of Applied Water - Ag | | | | 3,677.9 | | | | 4,983.2 | | | | 4,908.4 | PSA/DAU |
| b | Evapotranspiration of Applied Water - Managed Wetlands | | | | 127.5 | | | | 169.7 | | | | 162.9 | PSA/DAU |
| c | Evapotranspiration of Applied Water - Urban | | | | 313.2 | | | | 378.8 | | | | 384.4 | PSA/DAU |
| 48 | Evaporation and Evapotranspiration from Urban Wastewater | | | | 0.2 | | | | 0.1 | | | | 0.2 | REGION |
| 49 | Return Flows Evaporation and Evapotranspiration - Ag | | | | 122.0 | | | | 173.4 | | | | 174.2 | PSA/DAU |
| 50 | Urban Waste Water Produced | 253.0 | | | | 299.7 | | | | 312.6 | | | | REGION |
| 51a | Conveyance Evaporation and Evapotranspiration - Urban | | | | 4.9 | | | | 4.3 | | | | 4.3 | PSA/DAU |
| b | Conveyance Evaporation and Evapotranspiration - Ag | | | | 40.6 | | | | 61.5 | | | | 59.9 | PSA/DAU |
| c | Conveyance Evaporation and Evapotranspiration - Managed Wetlands | | | | 11.7 | | | | 16.3 | | | | 15.5 | PSA/DAU |
| d | Conveyance Loss to Mexico | | | | - | | | | - | | | | - | PSA/DAU |
| 52a | Return Flows to Salt Sink - Ag | | | | 637.0 | | | | 869.5 | | | | 931.5 | PSA/DAU |
| b | Return Flows to Salt Sink - Urban | | | | 314.3 | | | | 370.4 | | | | 381.2 | PSA/DAU |
| c | Return Flows to Salt Sink - Wetlands | | | | 179.2 | | | | 164.1 | | | | 169.3 | PSA/DAU |
| 53 | Remaining Natural Runoff - Flows to Salt Sink | | | | 33,981.9 | | | | 10,924.2 | | | | 2,457.9 | REGION |
| 54a | Outflow to Nevada | | | | | | | | | | | | | REGION |
| b | Outflow to Oregon | | | | - | | | | - | | | | - | REGION |
| c | Outflow to Mexico | | | | | | | | | | | | | REGION |
| 55 | Regional Imports | 851.4 | | | | 1,110.5 | | | | 668.5 | | | | REGION |
| 56 | Regional Exports | 2,268.2 | | | | 5,116.3 | | | | 3,763.4 | | | | REGION |
| 59 | Groundwater Net Change in Storage | 739.9 | | | | -150.8 | | | | -1,147.6 | | | | REGION |
| 60 | Surface Water Net Change in Storage | 2,752.0 | | | | -1,100.7 | | | | -2,411.8 | | | | REGION |
| 61 | Surface Water Total Available Storage | 16,145.6 | | | | 16,145.6 | | | | 16,145.6 | | | | REGION |

Colored spaces are where data belongs. N/A - Data Not Available "-" - Data Not Applicable "0" - Null value

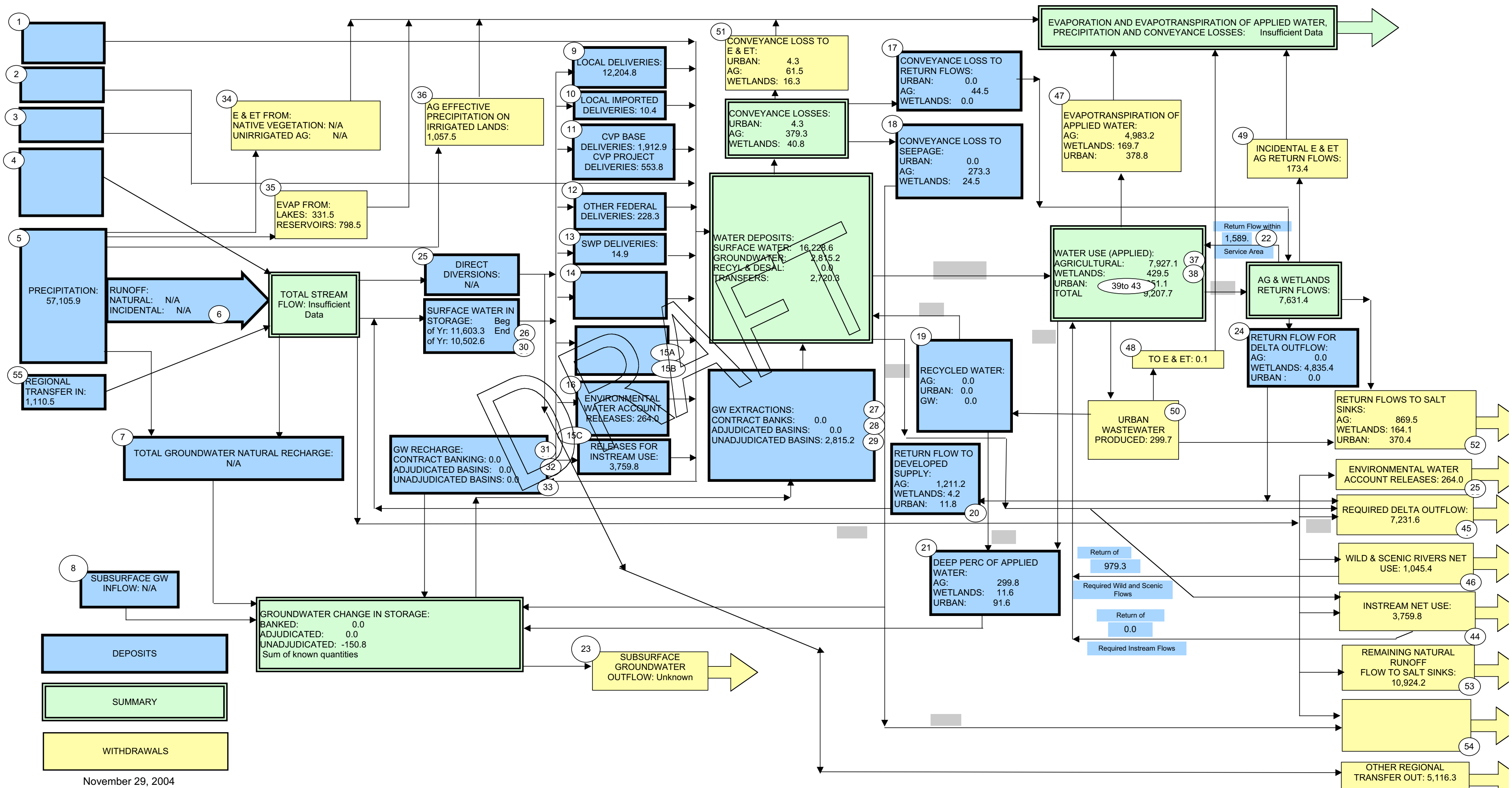
## Table 6-4
## Sacramento River Hydrologic Region Water Use and Distribution of Dedicated Supplies - TAF

| | 1998 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Applied Water Use | Net Water Use | Depletion | Applied Water Use | Net Water Use | Depletion | Applied Water Use | Net Water Use | Depletion |
| **WATER USE** | | | | | | | | | |
| **Urban** | | | | | | | | | |
| Large Landscape | 91.8 | | | 111.2 | | | 120.1 | | |
| Commercial | 113.1 | | | 140.4 | | | 137.5 | | |
| Industrial | 77.3 | | | 84.2 | | | 84.5 | | |
| Energy Production | 0.0 | | | 0.3 | | | 0.1 | | |
| Residential - Interior | 191.5 | | | 223.3 | | | 229.2 | | |
| Residential - Exterior | 243.8 | | | 291.7 | | | 297.3 | | |
| Evapotranspiration of Applied Water | | 313.2 | 313.2 | | 378.8 | 378.8 | | 384.4 | 384.4 |
| Irrecoverable Losses | | 0.2 | 0.2 | | 0.1 | 0.1 | | 0.2 | 0.2 |
| Outflow | | 312.0 | 309.4 | | 368.8 | 366.2 | | 379.6 | 377.0 |
| Conveyance Losses - Applied Water | 9.8 | | | 8.5 | | | 8.5 | | |
| Conveyance Losses - Evaporation | | 4.9 | 4.9 | | 4.3 | 4.3 | | 4.3 | 4.3 |
| Conveyance Losses - Irrecoverable Losses | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Outflow | | 4.9 | 4.9 | | 4.2 | 4.2 | | 4.2 | 4.2 |
| GW Recharge Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| GW Recharge Evap + Evapotranspiration | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| **Total Urban Use** | **727.3** | **635.2** | **632.6** | **859.6** | **756.2** | **753.6** | **877.2** | **772.7** | **770.1** |
| **Agriculture** | | | | | | | | | |
| On-Farm Applied Water | 5,841.2 | | | 7,927.1 | | | 7,781.7 | | |
| Evapotranspiration of Applied Water | | 3,677.9 | 3,677.9 | | 4,983.2 | 4,983.2 | | 4,908.4 | 4,908.4 |
| Irrecoverable Losses | | 122.0 | 122.0 | | 173.4 | 173.4 | | 174.2 | 174.2 |
| Outflow | | 1,494.4 | 497.7 | | 1,901.5 | 690.3 | | 1,927.7 | 972.5 |
| Conveyance Losses - Applied Water | 617.0 | | | 786.8 | | | 785.4 | | |
| Conveyance Losses - Evaporation | | 40.6 | 40.6 | | 61.5 | 61.5 | | 59.9 | 59.9 |
| Conveyance Losses - Irrecoverable Losses | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Outflow | | 199.3 | 139.3 | | 223.7 | 179.2 | | 232.3 | 186.9 |
| GW Recharge Applied Water | 0.0 | | | 0.0 | | | 0.0 | | |
| GW Recharge Evap + Evapotranspiration | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| **Total Agricultural Use** | **6,458.2** | **5,534.2** | **4,477.5** | **8,713.9** | **7,343.3** | **6,087.6** | **8,567.1** | **7,302.5** | **6,301.9** |
| **Environmental** | | | | | | | | | |
| Instream | | | | | | | | | |
| Applied Water | 3,699.6 | | | 3,759.8 | | | 3,747.5 | | |
| Outflow | | 3,699.6 | 3,699.6 | | 3,759.8 | 3,759.8 | | 3,747.5 | 3,747.5 |
| Wild & Scenic | | | | | | | | | |
| Applied Water | 2,754.1 | | | 2,024.7 | | | 885.0 | | |
| Outflow | | 1,797.2 | 1,797.2 | | 1,045.4 | 1,045.4 | | 320.5 | 320.5 |
| Required Delta Outflow | | | | | | | | | |
| Applied Water | 9,505.0 | | | 7,231.6 | | | 4,486.2 | | |
| Outflow | | 9,505.0 | 9,505.0 | | 7,231.6 | 7,231.6 | | 4,486.2 | 4,486.2 |
| Managed Wetlands | | | | | | | | | |
| Habitat Applied Water | 398.3 | | | 429.5 | | | 445.7 | | |
| Evapotranspiration of Applied Water | | 127.5 | 127.5 | | 169.7 | 169.7 | | 162.9 | 162.9 |
| Irrecoverable Losses | | 9.8 | 9.8 | | 14.4 | 14.4 | | 14.2 | 14.2 |
| Outflow | | 208.2 | 204.2 | | 193.3 | 189.1 | | 201.4 | 197.0 |
| Conveyance Losses - Applied Water | 40.8 | | | 42.0 | | | 23.3 | | |
| Conveyance Losses - Evaporation | | 1.9 | 1.9 | | 1.9 | 1.9 | | 1.3 | 1.3 |
| Conveyance Losses - Irrecoverable Losses | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Conveyance Losses - Outflow | | 5.2 | 5.2 | | 5.2 | 5.2 | | 2.7 | 2.7 |
| Total Managed Wetlands Use | 439.1 | 352.6 | 348.6 | 471.5 | 384.5 | 380.3 | 469.0 | 382.5 | 378.1 |
| **Total Environmental Use** | **16,397.8** | **15,354.4** | **15,350.4** | **13,487.6** | **12,421.3** | **12,417.1** | **9,587.7** | **8,936.7** | **8,932.3** |
| **TOTAL USE AND LOSSES** | **23,583.3** | **21,523.8** | **20,460.5** | **23,061.1** | **20,520.8** | **19,258.3** | **19,032.0** | **17,011.9** | **16,004.3** |
| **DEDICATED WATER SUPPLIES** | | | | | | | | | |
| **Surface Water** | | | | | | | | | |
| Local Deliveries | 13,939.5 | 13,939.5 | 13,021.9 | 12,204.8 | 12,204.8 | 11,172.4 | 8,843.0 | 8,843.0 | 8,075.4 |
| Local Imported Deliveries | 9.7 | 9.7 | 9.1 | 10.4 | 10.4 | 9.5 | 8.5 | 8.5 | 7.8 |
| Colorado River Deliveries | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CVP Base and Project Deliveries | 1,990.7 | 1,990.7 | 1,859.7 | 2,466.7 | 2,466.7 | 2,258.0 | 2,497.3 | 2,497.3 | 2,280.5 |
| Other Federal Deliveries | 198.0 | 198.0 | 185.0 | 228.3 | 228.3 | 209.0 | 239.5 | 239.5 | 218.7 |
| SWP Deliveries | 14.9 | 14.9 | 13.9 | 14.9 | 14.9 | 13.6 | 19.6 | 19.6 | 17.9 |
| Required Environmental Instream Flow | 3,962.8 | 3,962.8 | 3,962.8 | 3,422.2 | 3,422.2 | 3,422.2 | 3,133.4 | 3,133.4 | 3,133.4 |
| **Groundwater** | | | | | | | | | |
| Net Withdrawal | 1,408.2 | 1,408.2 | 1,408.2 | 2,173.5 | 2,173.5 | 2,173.5 | 2,270.6 | 2,270.6 | 2,270.6 |
| Artificial Recharge | 0.0 | | | 0.0 | | | 5.0 | | |
| Deep Percolation | 446.5 | | | 641.7 | | | 651.3 | | |
| **Reuse/Recycle** | | | | | | | | | |
| Reuse Surface Water | 1,613.0 | | | 1,898.6 | | | 1,363.8 | | |
| Recycled Water | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **TOTAL SUPPLIES** | **23,583.3** | **21,523.8** | **20,460.5** | **23,061.1** | **20,520.8** | **19,258.3** | **19,032.0** | **17,011.9** | **16,004.3** |
| *Balance = Use - Supplies* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* |

**Figure 6-7**
**Sacramento River Hydrologic Region 1998 Flow Diagram**
In Thousand Acre-Feet (TAF)



## Figure 6-8
## Sacramento River Hydrologic Region 2000 Flow Diagram
In Thousand Acre-Feet (TAF)



## Figure 6-9
## Sacramento River Hydrologic Region 2001 Flow Diagram
In Thousand Acre-Feet (TAF)